Ecosystem Services: An Essential Component of Sustainable Use

Ecosystem services are those functions of natural systems perceived as beneficial to human society. Examples of ecosystem services are maintenance of atmospheric gas balance and water quality and preserving and providing genetic material for pest-resistant plants that will grow under conditions that the more commonly used agricultural plants will not [for a discussion, see Westman (*1*) and Cairns and Niederlehner (*2*)]. At the planet's present population density of approximately 5.6 billion and the probability that it will reach 10 billion before the middle of the next century, human society is dependent on both a technological and ecological life support system. Since huge numbers of people now live in urban areas with little contact with natural systems, society is often unaware of its dependency on these systems. Making a commitment to ensuring that future generations have the same amenities that we enjoy involves protecting both the technological and ecological components of our life support system. Because the development of technological services may impair the delivery of ecosystem services, attention must be given to balancing the delivery of both technological and ecosystem services (*3*).

One of the serious flaws in the development of sustainable use of the planet for the future is the failure to anticipate episodic events that are either beyond human control or are not predicted by present models. For example, crop failures due to pests, plant diseases, drought, exceptionally heavy rainfall, or depletion of the soils causes poor production. In the reports of extremely heavy flooding in northern California during March 1995, it was not stressed that the flooding might have been markedly reduced had California not lost 91% of its wetlands in the last 200 years (*4*) or had it not devegetated large areas while simultaneously increasing the percentage of impervious surfaces such as roads, parking lots, and buildings. Each of these decisions (to fill in a wetland here, to build a parking lot there, to put a housing development somewhere else, and log yet another area) undoubtedly made sense when the decision was made in isolation from all the other decisions, but, when taken in the aggregate, all of these small decisions usually have environmental and other impacts far beyond those contemplated. This effect has been called the "tyranny of small decisions" by the economist A. E. Kahn (*5*) and subsequently by the ecologist W. E. Odum (*6*). Given the present level of information and the processing and storage capabilities of today's computers, there is little excuse for not becoming aware of the aggregate effects of a series of seemingly unrelated decisions. In addition to cumulative impacts, we should also determine if the planet has a time-dependent carrying capacity. ("Carrying capacity" is defined as that degree of environmental use beyond which no major human population increase will occur.) Can we continue present practices forever? Can we assume that long periods of equilibrium will exist in the next century? Some safety factors must be built in for the protection of ecosystem services.

To protect ecosystem services, we must determine which functions of ecosystems are essential to the survival of human society. As a corollary, we must determine which of the ecosystem services will not continue if other ecological functions, not perceived as beneficial to human society, are degraded. In this context, five assertions follow:

1) *Ecosystem services are as important to the survival of present human society as technological services.* For most of human existence, our life support system has been entirely ecological. Following the agricultural and industrial revolutions, the population exploded, per capita affluence increased dramatically, and, instead of being thinly distributed across the planet, large numbers of people were concentrated in urban and suburban areas. Without the technological life support system, which delivers food, energy, and transportation, the present population density, level of affluence, and distribution would not be possible. However, the operation of the technological life support system is threatening the ecological life support system, without which continued use of the planet at present population densities and levels of affluence will not be possible.

2) *Replacing the services provided by natural systems with comparable services provided by technological systems will be at least an order of magnitude more expensive.* Probably the best evidence on cost is from the space effort and Biosphere 2. Avise (*7*) notes that the estimated cost of supplying ecosystem services to seven people in Biosphere 2 was $9 million per person per year. Arguably, if these services were provided to larger numbers of people, there would be an economy of scale, but technology to do so at a reasonable cost does not appear probable for at least five decades or perhaps never.

3) *Sustainable use of the planet is impossible without ecosystem services.* Effective sustainable use will depend on robust estimates of the planet's carrying capacity for people at particular levels of affluence and dependence on technology and energy. This level of use must not threaten the integrity of the ecological life support systems.

4) *The quantity of ecosystem services per capita can be increased through ecological restoration of damaged ecosystems.* Obviously, damaged ecosystems are unlikely to provide the same level of services as healthy ecosystems. Therefore, without increasing the area involved, the level of services can be improved through restoration, repair, and healing.

5) *Ecosystem services can also be improved with existing undamaged ecosystems by focusing on their health rather than merely protecting them.* This assertion is merely an extension of the previous one. Once the systems are restored, repaired, or healed, they must be kept healthy to get optimal levels of services.

If we are indeed dependent on an ecological life support system, then attention must be given to this system lest it fail through ever-increasing pressure of population, expectations of affluence, and technological impacts. Because not much attention has been given to ecosystems as life support systems, this information must be generated quickly. Otherwise, we may lose components that are irreplaceable. The use of the word "services" has its drawbacks because we might be conditioned to think of ecosystems only in terms of their service functions. However, aesthetic appreciation, compassion for other species, and our responsibility as stewards of the planet cannot be ignored. On the other hand, for those who do not accept these views, the fact that our survival may depend on ecosystems services may change their behavior if the evidence is persuasive.

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